



INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁴ : A61K 31/37	A2	(11) International Publication Number: WO 89/ 07939 (43) International Publication Date: 8 September 1989 (08.09.89)
(21) International Application Number: PCT/US89/00450 (22) International Filing Date: 8 February 1989 (08.02.89) (31) Priority Application Numbers: 162,553 190,038 (32) Priority Dates: 1 March 1988 (01.03.88) 4 May 1988 (04.05.88) (33) Priority Country: US (60) Parent Application or Grant (63) Related by Continuation US 190,038 (CIP) Filed on 4 May 1988 (04.05.88) (71) Applicant (for all designated States except US): THE UPJOHN COMPANY [US/US]; 301 Henrietta Street, Kalamazoo, MI 49001 (US).		(72) Inventors; and (75) Inventors/Applicants (for US only) : REUSSER, Fritz [US/US]; 6548 Trotwood Street, Portage, MI 49081 (US). TARPLEY, William, G. [US/US]; 5207 Mapler- idge, Kalamazoo, MI 49008 (US). DOLAK, Lester [US/US]; 3261 East B Avenue, Plainwell, MI 49080 (US). ALTHAUS, Irene, W. [US/US]; 10220 Shuman Street, Portage, MI 49002 (US). (74) Agent: REYNOLDS, John, T.; Patent Law Depart- ment, The Upjohn Company, Kalamazoo, MI 49001 (US). (81) Designated States: AT (European patent), AU, BE (Eu- ropean patent), CH (European patent), DE (Euro- pean patent), DK, FI, FR (European patent), GB (European patent), IT (European patent), JP, KR, LU (European patent), NL (European patent), NO, SE (European patent), US. Published <i>Without international search report and to be repu- blished upon receipt of that report.</i>
(54) Title: COUMARINS TO INHIBIT REVERSE TRANSCRIPTASE IN HUMANS (57) Abstract The following compounds: 6-bromo-3-[(m-chlorophenyl)carbamoyl]-coumarin, 6-bromo-3-[(α,α,α -trifluoro-m-tolu- yl)carbamoyl]coumarin, 6-bromo-3-[(2,5-dichlorophenyl)carbamoyl]coumarin, [[bis(4-hydroxy-2-oxo-2H-1-benzopyran-3- yl)-methyl]cyclopentadienyl]cyclopentadienyl-iron, 3-cinnamoyl-4-hydroxy-coumarin, hexachlorocoumarin, 7-acetoxy- coumarin or [1-(2-oxo-2H-1-benzopyran-3-yl)ethylidene]-hydrazinecarboxylic acid phenylmethyl ester or pharmaceuti- cally acceptable salts thereof can be used to treat humans infected with one or more than one strain of a human immunodeficiency virus.		

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	FR	France	ML	Mali
AU	Australia	GA	Gabon	MR	Mauritania
BB	Barbados	GB	United Kingdom	MW	Malawi
BE	Belgium	HU	Hungary	NL	Netherlands
BG	Bulgaria	IT	Italy	NO	Norway
BJ	Benin	JP	Japan	RO	Romania
BR	Brazil	KP	Democratic People's Republic of Korea	SD	Sudan
CF	Central African Republic	KR	Republic of Korea	SE	Sweden
CG	Congo	LI	Liechtenstein	SN	Senegal
CH	Switzerland	LK	Sri Lanka	SU	Soviet Union
CM	Cameroon	LU	Luxembourg	TD	Chad
DE	Germany, Federal Republic of	MC	Monaco	TG	Togo
DK	Denmark	MG	Madagascar	US	United States of America
FI	Finland				

COUMARINS TO INHIBIT REVERSE TRANSCRIPTASE IN HUMANSField of the Invention

This invention is a novel treatment of patients infected with a human immunodeficiency virus.

5 Background of the Invention

The compounds used to practice the method claimed in this invention are known; however, none of the compounds are known to be useful to treat humans infected with human immunodeficiency virus or strains thereof.

10 An estimated one to one and one-half million people in the United States are infected with a human retrovirus, the human immunodeficiency virus type I, HIV-1, which is the etiological agent of acquired immunodeficiency syndrome, "\$2-Billion Program Urged for AIDS", Norman, C., Science, Vol. 234, pages 661-662 (1986). Of those
15 infected, an estimated two hundred and fifty thousands people will develop AIDS in the next five years, "The Epidemiology of AIDS: Current Status and Future Prospects", Curran, J.W., et al., Science, Vol. 229, No. 4720, pages 1352-1357 (1985). On March 20, 1987, the FDA approved the use of the compound, zidovudine (AZT), to treat AIDS
20 patients with a recent initial episode of Pneumocystis carinii pneumonia, AIDS patients with conditions other than Pneumocystis carinii pneumonia or patients infected with the virus with an absolute CD4 lymphocyte count of less than 200/mm³ in the peripheral blood. AZT is a known inhibitor of viral reverse transcriptase, an
25 enzyme necessary for human immunodeficiency virus replication.

It is known in the art that certain antibiotics and polyanionic dyes inhibit retrovirus reverse transcriptase. None of the compounds claimed in this invention were known to specifically inhibit human immunodeficiency virus reverse transcriptase.

30 Summary of the Invention

This invention is a method for treating a human infected with one or more than one strain of a human immunodeficiency virus which comprises administering an effective amount of a compound selected from the group consisting of 6-bromo-3-[(m-chlorophenyl)carbamoyl]-
35 coumarin, 6-bromo-3-[(α,α,α -trifluoro-m-toluy)carbamoyl]-coumarin, 6-bromo-3-[(2,5-dichlorophenyl)carbamoyl]-coumarin, [[bis(4-hydroxy-2-oxo-2H-1-benzopyran-3-yl)-methyl]cyclopentadienyl]cyclopentadienyl-iron, 3-cinnamoyl-4-hydroxy-coumarin, hexachlorocoumarin, 7-acetoxy-

coumarin or [1-(2-oxo-2H-1-benzopyran-3-yl)ethylidene]-hydrazinecarboxylic acid phenylmethyl ester or pharmaceutically acceptable salts thereof, to the infected human.

Detailed Description of the Invention

5 In this document, the term human immunodeficiency virus means human immunodeficiency virus type I, human immunodeficiency virus type II, or strains, apparent to one skilled in the art, which belong to the same viral family and which create similar physiological effects in humans as human immunodeficiency virus types I or II.

10 The structural formulas, if known, of each of the compounds used to practice the method claimed in this invention are given in the structure charts. The following compounds; 6-bromo-3-[(m-chlorophenyl)carbamoyl]-coumarin, 6-bromo-3-[(α,α,α -trifluoro-m-toluy)-carbamoyl]-coumarin, and 6-bromo-3-[(2,5-dichlorophenyl)carbamoyl]-
15 coumarin, were obtained commercially. The preparation of the compound, 3-cinnamoyl-4-hydroxy-coumarin, is described in "Zur Chemie des 4-Hydroxy-cumarins", Monatshefte fur chemi, Vol. 87, pages 439-446 (1956). The preparation of the compound, 7-acetoxycoumarin, is described in Chem. Ber., Vol. 12, pages 993-999 (1879). The compound, hexachlorocoumarin, is prepared when chlorine is bubbled into
20 an ethanolic solution of coumarin in the presence of light. When there is no longer any detectable presence of the starting material in solution, the solvent is removed and the mixture of polychlorinated products is separated by chromatography. The compound, [[bis-(4-hydroxy-2-oxo-2H-1-benzopyran-3-yl)-methyl]cyclopentadienyl]cyclopentadienyl-iron, is prepared by condensing 2.0 equivalents of commercially available 4-hydroxycoumarin with 1.5 equivalents of commercially available ferrocenecarboxaldehyde in ethanol following the general procedures described by Sullivan, et al., JACS, Vol. 65,
25 July-December, pages 2288-2291 (1943) "Studies on 4-Hydroxycoumarins. II. The Condensation of Aldehydes with Hydroxycoumarins". The compound, [1-(2-oxo-2H-1-benzopyran-3-yl)ethylidene]-hydrazinecarboxylic acid phenylmethyl ester, is prepared by condensing commercially available 3-acetylcoumarin with commercially available benzyl carbamate in the presence of glacial acetic acid in absolute methanol. The reagents are refluxed, diluted with water, cooled and filtered to provide the crystalline compound.

35 These compounds or pharmaceutically acceptable salts thereof can

be used and administered in practicing the method claimed in this invention. Pharmaceutically acceptable salts refers to those salts of the compounds claimed in this invention which would be readily apparent to a manufacturing pharmaceutical chemist to be equivalent
5 to the parent compound in properties such as formulation, stability, patient acceptance and bioavailability.

Those skilled in the art would know how to formulate the compounds used to practice the method claimed in this invention into appropriate pharmaceutical dosage forms. Examples of the dosage
10 forms include oral formulations, such as tablets or capsules, or parenteral formulations, such as sterile solutions.

When the compounds used to practice the method claimed in this invention are administered orally, an effective amount is from about 1 to 100 mg per kg per day. A typical unit dose for a 70 kg human
15 would be from about 200 mg to 1000 mg taken one to four times per day. Either solid or fluid dosage forms can be prepared for oral administration. Solid compositions are prepared by mixing the compounds used to practice the method claimed in this invention with conventional ingredients such as talc, magnesium stearate, dicalcium
20 phosphate, magnesium aluminum silicate, calcium sulfate, starch, lactose, acacia, methyl cellulose, or functionally similar pharmaceutical diluents and carriers. Capsules are prepared by mixing the compounds used to practice the method claimed in this invention with an inert pharmaceutical diluent and placing the mixture into an appro-
25 priately sized hard gelatin capsule. Soft gelatin capsules are prepared by machine encapsulation of a slurry of the compounds used to practice the method claimed in this invention with an acceptable inert oil such as vegetable oil or light liquid petrolatum. Syrups are prepared by dissolving the compounds used to practice the method
30 claimed in this invention in an aqueous vehicle and adding sugar, aromatic flavoring agents and preservatives. Elixirs are prepared using a hydroalcoholic vehicle such as ethanol, suitable sweeteners such as sugar or saccharin and an aromatic flavoring agent. Suspensions are prepared with an aqueous vehicle and a suspending agent
35 such as acacia, tragacanth, or methyl cellulose.

When the compounds used to practice the method claimed in this invention are administered parenterally, it can be given by injection or by intravenous infusion. An effective amount is from about 1 to

100 mg per kg per day. Parenteral solutions are prepared by dissolving the compounds used to practice the method claimed in this invention in water and filter sterilizing the solution before placing in a suitable sealable vial or ampule. Parenteral suspensions are prepared in substantially the same way except a sterile suspension vehicle is used and the compounds used to practice the method claimed in this invention are sterilized with ethylene oxide or suitable gas before it is suspended in the vehicle.

The exact route of administration, dose, or frequency of administration would be readily determined by those skilled in the art and is dependant on the age, weight, general physical condition, or other clinical symptoms specific to the patient to be treated.

Patients to be treated would be those individuals: 1) infected with one or more than one strain of a human immunodeficiency virus as determined by the presence of either measurable viral antibody or antigen in the serum and 2) having either a symptomatic AIDS defining infection such as i) disseminated histoplasmosis, ii) isoporiasis, iii) bronchial and pulmonary candidiasis including pneumocystis pneumonia iv) non-Hodgkin's lymphoma or v) Kaposi's sarcoma and being less than sixty years old; or having an absolute CD4 lymphocyte count of less than $200/\text{mm}^3$ in the peripheral blood. Treatment would consist of maintaining an inhibitory level of the compounds disclosed herein in the patient at all times and would continue until the occurrence of a second symptomatic AIDS defining infection indicates alternate therapy is needed.

Without further elaboration, those skilled in the art can practice the present invention to its fullest extent. The following detailed examples further describe how to use the compounds claimed in this invention to treat humans infected with one or more than one strain of a human immunodeficiency virus. These examples are merely illustrative and are not limitations of the preceding disclosure. Those skilled in the art will promptly recognize appropriate variations from the examples. In each example, any compound claimed in this invention could replace the compound used in the particular example.

Example 1 Hard Gelatin Capsules

One thousand two-piece hard gelatin capsules for oral use, each capsule containing 50 mg of hexachlorocoumarin, are prepared from the

-5-

following:

	Hexachlorocoumarin	50 gm
	Lactose	100 gm
	Cornstarch	20 gm
5	Talc	20 gm
	Magnesium Stearate	2 gm

The hexachlorocoumarin is added to the other ingredients, mixed and encapsulated in the usual manner.

Example 2 Tablets

10 One thousand tablets, each containing 50 mg of hexachlorocoumarin, are prepared from the following:

	Hexachlorocoumarin	50 gm
	Lactose	75 gm
	Cornstarch	50 gm
15	Magnesium Stearate	4 gm
	Light liquid petrolatum	5 gm

20 The hexachlorocoumarin is added to the other ingredients, mixed and slugged. The slugs are broken down by forcing through a number sixteen screen. The resulting granules are then compressed into tablets.

Example 3 Parenteral solution

A sterile aqueous solution for parenteral intravenous injection containing 150 mg of hexachlorocoumarin in one liter of solution is prepared from the following:

25	Hexachlorocoumarin	150 mg
	Water for injection, qs	1000 mg

The hexachlorocoumarin is sterilized, added to the sterile water, filled into sterile containers and sealed.

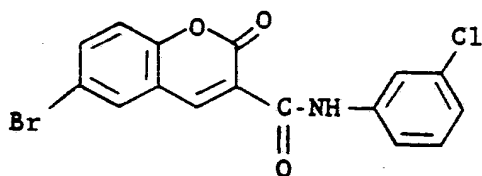
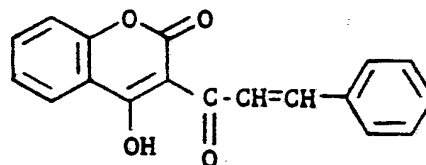
30 The utility of this invention is demonstrated by the ability of the compounds used to practice the method claimed in this invention to inhibit viral reverse transcriptase, an enzyme essential for human immunodeficiency virus replication. This enzyme has characteristics which differentiate it from other known cellular polymerases and it is a unique enzyme which is not found in uninfected cells. Viral
35 reverse transcriptase is found in extracts from bacterial clones prepared according to the procedure described by Goff, S. P., et al., Journal of Virology, Vol. 59, No. 3, pages 743-745 (1986) "Expression of Reverse Transcriptase Activity of Human T-lymphotropic Virus Type

III (HTLV-III/LAV) in *Escherichia coli*". Inhibition of this enzyme is determined in a cell free assay which measures the level of radioactive precursors incorporated into DNA. Extracts prepared according to the procedure of Kleid, D. G., et al., Science, Vol. 214, No. 4525, pages 1125-1129 (1981) "Cloned Virla Protein Vaccine for Foot-and-Mouth Disease: Responses in Cattle and Swine" are incubated in a mixture of inhibitor, 20 mM dithiothreitol, 60 mM sodium chloride, 0.05% NP-40, 10 mM magnesium chloride, 50 mM Tris pH 8.3, 10 μ M [³⁵S]-labeled deoxynucleoside-5'-triphosphate, 10 μ g/ml RNA template (poly rC or poly rA) and 5 μ g/ml DNA primer (oligo dG or oligo dT) for 30 minutes at 37°C. Incorporation of radio-labeled precursor is determined by spotting aliquots of the reaction mixture on DE81 paper, washing the papers to remove unincorporated precursor, drying and determining counts. Table 1 contains the results of the assay for the compounds used to practice the method claimed in this invention.

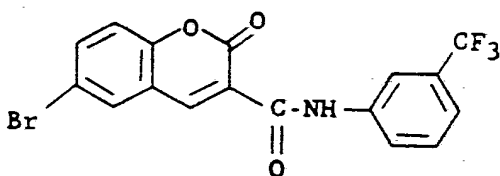
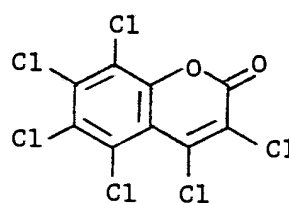
-7-

TABLE 1

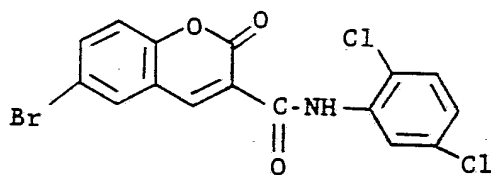
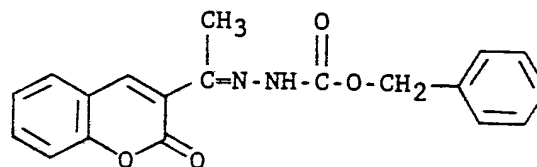
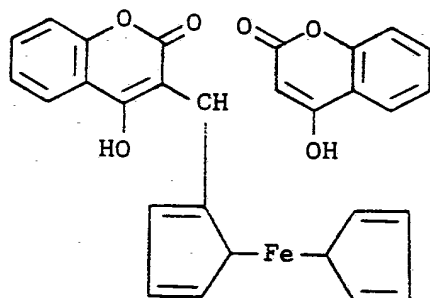
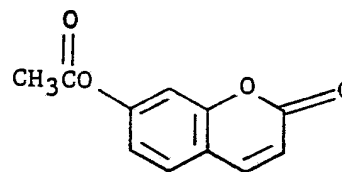
	<u>COMPOUND (0.1 mM)</u>	<u>%INHIBITION</u>
5	6-bromo-3-[(m-chlorophenyl)- carbamoyl]-coumarin	28
	6-bromo-3-[(α,α,α -trifluoro- m-toluy)carbamoyl]-coumarin	31
10	6-bromo-3-[(2,5-dichlorophenyl)- carbamoyl]-coumarin	42
15	[[bis(4-hydroxy-2-oxo-2H-1-benzo- pyran-3-yl)-methyl]cyclopentadienyl]- cyclopentadienyl-iron	60
	3-cinnamoyl-4-hydroxy-coumarin	35
20	hexachlorocoumarin	34
	[1-(2-oxo-2H-1-benzopyran-3-yl)- ethylidene]-hydrazinecarboxylic acid phenylmethyl ester	31
25	7-acetoxycoumarin	23

STRUCTURE CHART6-bromo-3-[(m-chlorophenyl)-
carbamoyl]-coumarin

3-cinnamoyl-4-hydroxy-coumarin

6-bromo-3-[α,α,α-trifluoro-
m-toluy]carbamoyl]-coumarin

hexachlorocoumarin

6-bromo-3-[(2,5-dichlorophenyl)-
carbamoyl]-coumarin[1-(2-oxo-2H-1-benzopyran-3-yl)-
ethylidene]-hydrazinecarboxylic
acid phenylmethyl ester[[bis(4-hydroxy-2-oxo-2H-1-benzo-
pyran-3-yl)-methyl]cyclopentadi-
enyl]cyclopentadienyl-iron

7-acetoxycoumarin

CLAIMS

1. Use of a compound selected from the group consisting of 6-bromo-3-[(m-chlorophenyl)carbamoyl]-coumarin, 6-bromo-3-[(α,α,α -trifluoro-m-toluy)carbamoyl]-coumarin,
5 m-toluy)carbamoyl]-coumarin, 6-bromo-3-[(2,5-dichlorophenyl)carbamoyl]-coumarin, [[bis(4-hydroxy-2-oxo-2H-1-benzopyran-3-yl)-methyl]-cyclopentadienyl]cyclopentadienyl-iron, 3-cinnamoyl-4-hydroxy-coumarin, hexachlorocoumarin, 7-acetoxycoumarin or [1-(2-oxo-2H-1-benzopyran-3-yl)ethylidene]-hydrazinecarboxylic acid phenylmethyl ester or
10 a pharmaceutically acceptable salt thereof, to prepare a medicament to treat a human infected with one or more strains of a human immunodeficiency virus.
2. A method according to claim 1 where the effective amount of the
15 compound is from about 1 to 100 mg per kg per day.
3. A method according to claim 1 where the compound is 6-bromo-3-[(m-chlorophenyl)carbamoyl]-coumarin.
- 20 4. A method according to claim 1 where the compound is 6-bromo-3-[(α,α,α -trifluoro-m-toluy)carbamoyl]-coumarin.
5. A method according to claim 1 where the compound is 6-bromo-3-[(2,5-dichlorophenyl)carbamoyl]-coumarin.
25
6. A method according to claim 1 where the compound is [[bis(4-hydroxy-2-oxo-2H-1-benzopyran-3-yl)-methyl]cyclopentadienyl]cyclopentadienyl-iron.
- 30 7. A method according to claim 1 where the compound is 3-cinnamoyl-4-hydroxy-coumarin.
8. A method according to claim 1 where the compound is hexachlorocoumarin.
35
9. A method according to claim 1 where the compound is 7-acetoxycoumarin.

-10-

10. A method according to claim 1 where the compound is [1-(2-oxo-2H-1-benzopyran-3-yl)ethylidene]-hydrazinecarboxylic acid phenyl-methyl ester.